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NATIONAL DAM SAFETY PROGRAM. WHITEWOOD LAKE DAM (MO 30135), MIS--ETC(U)
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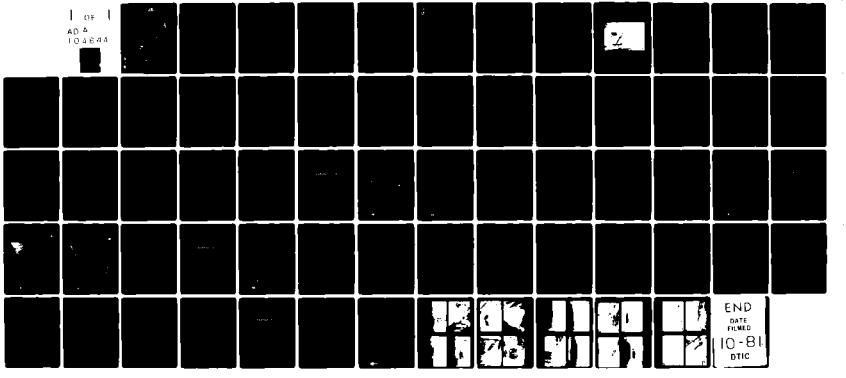

LEVEL II

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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

WHITEWOOD LAKE DAM

PERRY COUNTY, MISSOURI

MO 30135

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
... Serving the Army
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

APRIL 1981

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

WHITEWOOD LAKE DAM

PERRY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30135

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

APRIL 1981

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Whitewood Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Whitewood Lake Dam (MO No. 30135)

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 16 JUL 1981 — Date

APPROVED BY: SIGNED — Colonel, CE, Commanding — 17 JUL 1981 — Date

PHASE 1 REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	Whitewood Lake Dam
State Located:	Missouri
County Located:	Perry
Stream:	Tributary of Whitewater River
Date of Inspection:	18 December 1980

Whitewood Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 3 miles downstream of the dam. Located within this zone are Highway BB, four trailers, a dwelling, and a barn. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken. The dam is in the small size classification, since it is greater than 25 ft high but less than 40 ft high, and the maximum storage capacity is greater than 50 acre-ft but less than 1,000 acre-ft.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 15 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the low height of the dam and the small storage capacity, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 1 percent probability flood will not overtop the dam. The 1 percent

probability flood is one that has a 1 percent chance of being exceeded in any given year.

Deficiencies visually observed by the inspection team were: (1) lack of wave protection on the upstream face; (2) seepage at the left abutment-dam contact; and (3) slight leakage from the spillway pipe. Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action promptly to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Steve Brady, P.E. (AEI)

Tom Beckley, P.E. (AEI)

Dave Daniels, P.E. (HEI)

Gene Wertepny, P.E. (HEI)

AERIAL VIEW OF LAKE AND DAM

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APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Whitewood Lake Dam in Perry County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Whitewood Lake Dam is an earth structure approximately 32 ft high and 325 ft long at the crest. In this report, right and left orientation is based on looking in the downstream direction. The appurtenant works consist of a drop inlet and pipe spillway and a steel drawdown pipe with the valve at the downstream end.

B. Location:

The dam is located in the southwest part of Perry County, Missouri on a tributary of Whitewater River. The dam and lake are within the Parker Lake, Missouri 7.5 minute quadrangle sheet (Section 19, T34N, R9E-latitude 37 deg. 37.8 min. , longitude 90 deg. 04.6 min.). Sheet

2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 32 ft and a maximum storage capacity of approximately 122 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification. The estimated damage zone extends approximately 3 miles downstream of the dam. Located within this zone are Highway BB, four trailers, a dwelling, and a barn. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken.

E. Ownership:

The dam is owned by Stanley White. The owner's address is Route 5, Perryville, Missouri 63775 (telephone:314-547-4804).

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes and is used as a pay fishing lake.

G. Design and Construction History:

The dam was constructed in 1970 by Harold Reshardy. The owner indicted that borrow for the dam came from the lake area and consisted of clay and rock. He said that the embankment was constructed by bulldozers and that a 5 ft deep cutoff trench was incorporated under the dam. The only modification to the dam was made in 1974 when the emergency spillway, which was originally located in the left abutment, was filled in.

Another dam and lake (hereinafter referred to as the "upper dam" or "upper lake") were constructed in about 1973 approximately 1,000 ft upstream of Whitewood Lake Dam. This "upper dam" is approximately 18 ft high and 350 ft long with the top of dam at elevation 732.5 and the crest of the spillway at elevation 728.7. A plan view of the "upper dam" is presented on Sheet 4 of Appendix A. The effect of the "upper dam" was considered in the routing analysis as explained in Section 5 of the text and in Appendix C. At the time of the report, this upper dam was not included in the Dam Safety Program (no ID number).

H. Normal Operating Procedures:

Normal flows are discharged through the uncontrolled drop inlet and pipe spillway. The 4 in. drawdown pipe was used last fall to drain the lake for fish control. The owner reported that the highest water level was approximately 2 ft below the top of dam and occurred in 1974 after an 8 in. rain. However, an emergency spillway formerly located in the left abutment was operating at that time. The emergency spillway has since been filled in. The dam has never been overtopped.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the USGS quad sheet, is approximately 126 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through an uncontrolled spillway.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 723.4): 41 cfs

(3) Estimated Capacity of Primary Spillway: 41 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: Unknown

(5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(7) Gated Spillway Capacity at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 720.0 for the crest of the spillway riser structure

(estimated from quadrangle map).

(1) Top of Dam: 723.4

(2) Principal Spillway Crest: 720.0

(3) Emergency Spillway Crest: Not Applicable

(4) Principal Outlet Pipe Invert: 694.9

(5) Streambed at Centerline of Dam: 691.2

(6) Pool on Date of Inspection: 715.5

(7) Apparent High Water Mark: Not Evident

(8) Maximum Tailwater: Unknown

(9) Upstream Portal Invert Diversion Tunnel: Not Applicable

(10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Principal Spillway Crest: 900 ft

(2) At Emergency Spillway Crest: Not Applicable

(3) At Top of Dam: 920 ft

E. Storage Capacities:

(1) At Principal Spillway Crest: 95 acre-ft

(2) At Emergency Spillway: Not Applicable

(3) At Top of Dam: 122 acre-ft Crest: Not Applicable

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 7.5 acres

(2) At Emergency Spillway Crest: Not Applicable

(3) At Top of Dam: 8.6 acres

G. Dam:

(1) Type: Earth

(2) Length at Crest: 325 ft

(3) Height: 32 ft

(4) Top Width: 11 ft

(5) Side Slopes: Upstream Varies, 2.6H:1V to 10.0H:1V, Downstream Varies, 2.8H:1V to 3.6H:1V

(6) Zoning: None

(7) Impervious Core: None

(8) Cutoff: Yes, 5 ft deep (from owner)

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

(1) Location: Station 3+00 (see Sheet 3, Appendix A)

(2) Type: Reinforced concrete pipe, drop inlet and pipe

I.2 Emergency Spillway:

(1) Location: Not Applicable

(2) Type: Not Applicable

J. Regulating Outlets:

The only regulating outlet is a 4 in. diameter drawdown pipe near the left abutment. The valve for the pipe is on the downstream end. The pipe was last used one year ago.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

Design assistance was provided by the Soil Conservation Service. However, the owner did not strictly adhere to the recommendations made by SCS. The dam is 4 ft higher than indicated by the SCS information, and the spillway pipe is reinforced concrete instead of corrugated metal. Also, the emergency spillway originally recommended and originally incorporated in the dam, has now been filled in. The information provided by SCS included: (1) drainage area and hydraulic design data for the spillway; (2) lake surface and storage data; (3) a typical section of the dam at the spillway location; (4) a cross section of the valley along the centerline of the dam; and (5) miscellaneous survey information.

A. Surveys:

Surveys were made by SCS previous to construction for the purpose of obtaining storage and embankment quantities. Sheet 3 of Appendix A presents a plan, profile, and cross section of the dam from survey data obtained during our site inspection. The top of the entrance to the principal spillway riser was used as a reference point to determine all other elevations. It is estimated that this site datum corresponds to mean sea level (MSL) elevation 720.0 (estimated from quad sheet).

B. Geology and Subsurface Materials:

The site is located in the north-central portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus, and deep valleys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists primarily of the Gasconade formation and the Rubidoux formation. The Gasconade formation is predominantly a light brownish-gray, cherty dolomite. The Rubidoux formation consists of sandstone, dolomitic sandstone, and cherty dolomite. Caves and springs are common in these formations. The publication "Caves of Missouri" lists a total of four caves known to exist in Perry County. These caves are clustered in a 12 sq mile area about 10 miles east of the site.

The "Geologic Map of Missouri" indicates several normal faults southwest and northwest of the site about 5 miles away. It should also be noted that the site is located in seismic zone 2 (moderate damage

zone) but is near the boundary of zone 3 (major damage zone - see Sheet 3 of Appendix B).

Soils in the area of the dam site appear to be primarily thin deposits of residual silts and clays with rock fragments. The soils are of the Union-Fullerton-McGirk Soil Associations and have developed from thin loess deposited over weathered material from cherty dolomites. The loessial thickness map indicates that upland areas may have between 2.5 and 5.0 ft of loess cover. Auger probes in the dam indicated a red brown cherty, silty clay (CL-ML).

C. Foundation and Embankment Design:

The owner indicated that several backhoe cuts were made to investigate the soils in the area of the embankment. He indicated that bedrock was encountered 4 or 5 ft below the streambed level and that a 5 ft deep cutoff was constructed under the dam. He indicated the borrow for the dam came mainly from the lake area. No soil profile data or embankment and foundation design information were available.

D. Hydrology and Hydraulics:

Hydrology and hydraulics information as listed in Section 2.1 was obtained from SCS. Based on this information, a field check of spillway dimensions and embankment elevations, and a check of the drainage area on the USGS quad sheet, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C.

E. Structures:

No design information was available for the spillway structure or the drawdown pipe.

2.2 CONSTRUCTION:

No construction inspection records were available.

2.3 OPERATION:

The only operating facility is the 4 in. drawdown pipe. It was last used one year ago when the lake was drained for fish control purposes. A 4 in. electric pump was used in combination with the drawdown pipe, and the owner indicated that it took 45 days to drain the lake.

2.4 EVALUATION:

A. Availability:

The engineering data available are as listed in Section 2.1. No seepage or stability analyses or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 18 December 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

The owner was in the area but did not accompany the inspection team. Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appeared in fairly good condition. The upstream slope is grass covered with a 5 ft berm at normal pool level. There is no wave protection, but not much erosion was noted. No trees, animal holes, or sloughing was noted. See Photo No. 1.

The crest of the dam is clear with a dirt roadway. The crest appeared fairly uniform horizontally and vertically, and no cracking or unusual movement was observed. See Photo No. 2.

The downstream slope is grass covered and clear of trees and brush. No sloughs, animal holes, significant erosion, or seepage were observed on the downstream face. There was no significant erosion at either abutment contact. See Photo No. 3.

A seepage area was observed at the left abutment downstream contact. Water discharge was less than 1 gpm on the day of inspection, and the water did not appear to be carrying soil particles (see Photo No. 4). The owner indicated that the leak has been there since the dam was constructed and is caused by a large rock outcrop which could not be removed. The owner indicated that the quantity of seepage has not changed since the dam was built.

C. Appurtenant Structures:

C.1 Principal Spillway:

The spillway consistsof a 24 in. diameter reinforced concrete riser (drop inlet) with a 16 in. diameter reinforced concrete pipe under the dam. The intake is surrounded by a wire fence and high weeds. The top of the riser lip has experienced some spalling but otherwise appears in satisfactory condition (see Photo No. 5).

The outlet for the principal spillway is a 16 in. reinforced concrete pipe (headwall at the outlet end - see Photo No. 6), which discharges into an unlined plunge pool. A small amount of water was dripping from the outlet pipe indicating a leak, which probably originates at the intake (the pool level was almost 5 ft below the crest of the spillway on the day of inspection).

A 4 in. diameter steel drawdown pipe is located near the left abutment. The valve for the drawdown pipe is located on the downstream end. Two small 1/2 in. diameter pipes with valves are attached to the larger pipe for watering purposes for a hog feedlot downstream of the dam (see Photos 7 and 8).

C.2 Emergency Spillway:

An emergency spillway was formerly located in the left abutment. The owner indicated that it was filled in 1974.

D. Reservoir:

The watershed is primarily wooded. Approximately 60 percent of the watershed is controlled by an upstream dam and lake. The upper dam and lake were considered in the hydrology and hydraulics analyses as discussed in section 5 and Appendix C. A plan sketch of the upper dam and lake is presented as Sheet 5 of Appendix A. Photographs 12 through 16 show the upper dam, lake, and spillway.

The slopes adjacent to Whitewood Lake are moderate, and no sloughing or serious erosion was noted. No significant sedimentation was observed.

E. Downstream Channel:

The downstream channel is well defined and wooded on both banks immediately downstream of the dam. Hog barns are located on both banks immediately downstream of the dam (see Photos 9 and 10).

3.2 EVALUATION:

There is no wave protection provided for the upstream face of the embankment. Although there did not appear to be significant wave erosion, it may become a problem in the future. The seepage noted in the left abutment contact should be monitored in an effort to detect any increase in flow. The apparent leak in the spillway pipe should be located and repaired.

Because the 4 in. diameter pipe valve is located on the downstream side of the dam, the full head of water impounded by the dam is acting entirely through the dam. The area around the drain outlet should be periodically inspected for seepage which might indicate a leak or rupture of the pipe and could eventually initiate a piping failure through the embankment.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

The only operating facilities are the valves for the 4 in. diameter drawdown pipe. The small valves for the 1/2 in. pipes (see Photo No. 8) are opened periodically for watering hogs downstream of the dam. The 4 in. gate valve is normally closed and was last opened when the lake was drained for fish control last year. The pool is normally controlled by rainfall, runoff, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM:

Some maintenance of the dam has been done. The crest and both faces were clear of trees and brush.

4.3 MAINTENANCE OF OPERATING FACILITIES:

To our knowledge, there is no regular maintenance of operating facilities.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The lack of riprap on the upstream face of the dam, and an apparent leak in the spillway pipe are deficiencies that could become serious if not corrected. A program of regular operation and maintenance of the 4 in. drawdown pipe valve should be established.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

Hydrologic and hydraulic design data provided by SCS were listed in Section 2.1. These data were reviewed and used in our analyses where applicable.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. The owner of the dam indicated that the highest water level was approximately 2 ft below the top of the dam and occurred in 1974 after an 8 in. rain. However, it should be noted that an emergency spillway in the left abutment was operating at that time. The emergency spillway lake has since been filled in.

C. Visual Observations:

The spillway was apparently leaking slightly on the day of the site inspection. It is recommended that the leak be located and repaired.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U.S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevation, and (2) an estimate of the reservoir storage and the pool and drainage areas from the Parker Lake, Missouri, 7.5 minute USGS quad sheet, and (3) storage and drainage area data provided by SCS.

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 15 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the low

height of the dam (32 ft) and the small storage capacity (122 acre-ft), 50 percent of the PMF has been determined to be the appropriate spillway design flood. The spillway will pass the 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 3,250 cfs. For 50 percent of the PMP, the peak inflow was 1,575 cfs.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by 2.3 ft at elevation 725.7. The duration of the overtopping will be 11.5 hours, and the maximum outflow will be 2,970 cfs. The maximum discharge capacity of the spillways is 41 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 1.5 ft at elevation 724.9. The maximum outflow will be 1,400 cfs, and the duration of overtopping will be 7.8 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

A portion (74 acres) of Whitewood Lake Dam watershed is controlled by a dam and reservoir (upper dam). This dam is 18 ft high and approximately 350 ft long. The reservoir surface area at normal pool is 2.5 acres and at top of dam is 2.8 acres. The reservoir storage is approximately 20 acre-ft at normal pool and 23 acre-ft at top of dam. The dam has a rock cut spillway with a maximum capacity of 60 cfs at top of dam elevation. The downstream toe of the dam is about 5 ft below the normal pool elevation of Whitewood Lake Dam.

To consider the effect of the upper dam, the outflow hydrograph of the upper dam was combined with the inflow hydrograph of Whitewood Lake Dam (lower dam). Then, the combined hydrograph was routed through the lake and spillway of the lower dam.

The effect of the upper dam was studied, assuming that (1) the upper dam will resist the overtopping and (2) that the upper dam will breach during overtopping.

The routing study indicates that a breach of the upper dam will not significantly increase the overtopping potential of Whitewood Lake Dam.

The following parameters were used in the breach analysis ($B cards of input data, Sheet 12, Appendix C):

1) Breach bottom width = 10 ft
2) Side slope of breach (z) = 0.5H to 1.0V
3) Breach bottom elevation = 720.0

height of the dam (32 ft) and the small storage capacity (122 acre-ft), 50 percent of the PMF has been determined to be the appropriate spillway design flood. The spillway will pass the 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 3,250 cfs. For 50 percent of the PMP, the peak inflow was 1,575 cfs.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by 2.3 ft at elevation 725.7. The duration of the overtopping will be 11.5 hours, and the maximum outflow will be 2,970 cfs. The maximum discharge capacity of the spillways is 41 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 1.5 ft at elevation 724.9. The maximum outflow will be 1,400 cfs, and the duration of overtopping will be 7.8 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

A portion (74 acres) of Whitewood Lake Dam watershed is controlled by a dam and reservoir (upper dam). This dam is 18 ft high and approximately 350 ft long. The reservoir surface area at normal pool is 2.5 acres and at top of dam is 2.8 acres. The reservoir storage is approximately 20 acre-ft at normal pool and 23 acre-ft at top of dam. The dam has a rock cut spillway with a maximum capacity of 60 cfs at top of dam elevation. The downstream toe of the dam is about 5 ft below the normal pool elevation of Whitewood Lake Dam.

To consider the effect of the upper dam, the outflow hydrograph of the upper dam was combined with the inflow hydrograph of Whitewood Lake Dam (lower dam). Then, the combined hydrograph was routed through the lake and spillway of the lower dam.

The effect of the upper dam was studied, assuming that (1) the upper dam will resist the overtopping and (2) that the upper dam will breach during overtopping.

The routing study indicates that a breach of the upper dam will not significantly increase the overtopping potential of Whitewood Lake Dam.

The following parameters were used in the breach analysis ($B cards of input data, Sheet 12, Appendix C):

1) Breach bottom width = 10 ft
2) Side slope of breach (z) = 0.5H to 1.0V
3) Breach bottom elevation = 720.0

4) Failure time - 1/2 hr
5) Initial water surface elevation = 731.0 (Normal pool)
6) Failure elevation = 733.88 (PMF Water surface elevation) and 732.0 (top of dam elevation).

The computer input and a summary of the computer output, for the breach analysis, are shown on Sheets 12, 13, and 14 of Appendix C.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1.B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The only post construction change was the filling in of the emergency spillway which was originally located in the left abutment.

E. Seismic Stability:

The structure is located in seismic zone 2. It is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected, or controlled. These items are: (1) lack of wave protection on the upstream face; (2) seepage at the left abutment-dam contact; and (3) slight leakage from the spillway pipe.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 15 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

If the deficiencies listed in paragraph 7.1.A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. The items recommended in paragraph 7.2 should be pursued promptly.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 2. It is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

(1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent possible erosion due to the increase of capacity.

B. O and M Procedures:

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.

(2) Wave protection should be provided for the upstream face of the dam.

(3) The leak in the spillway structure should be located and repaired.

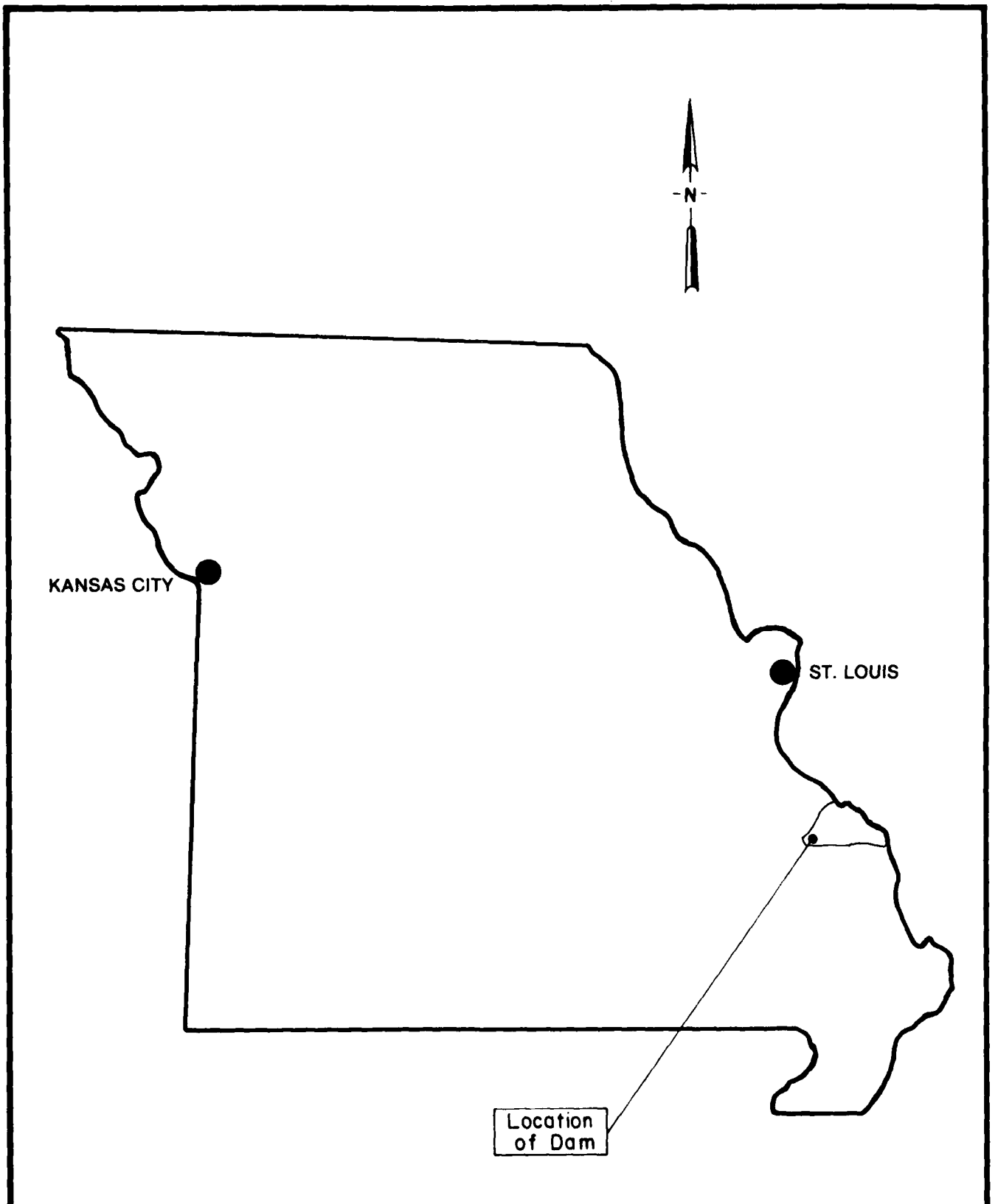
(4) The seepage area in the left abutment contact should be monitored to detect an increase in flow or soil particles being carried with the seepage water.

(5) The drawdown pipe valve should be operated periodically and maintained.

(6) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams. The report of the inspection should be made a matter of record.

APPENDIX A

Dam Location and Plans



LOCATION MAP

HANSON ENGINEERS INCORPORATED

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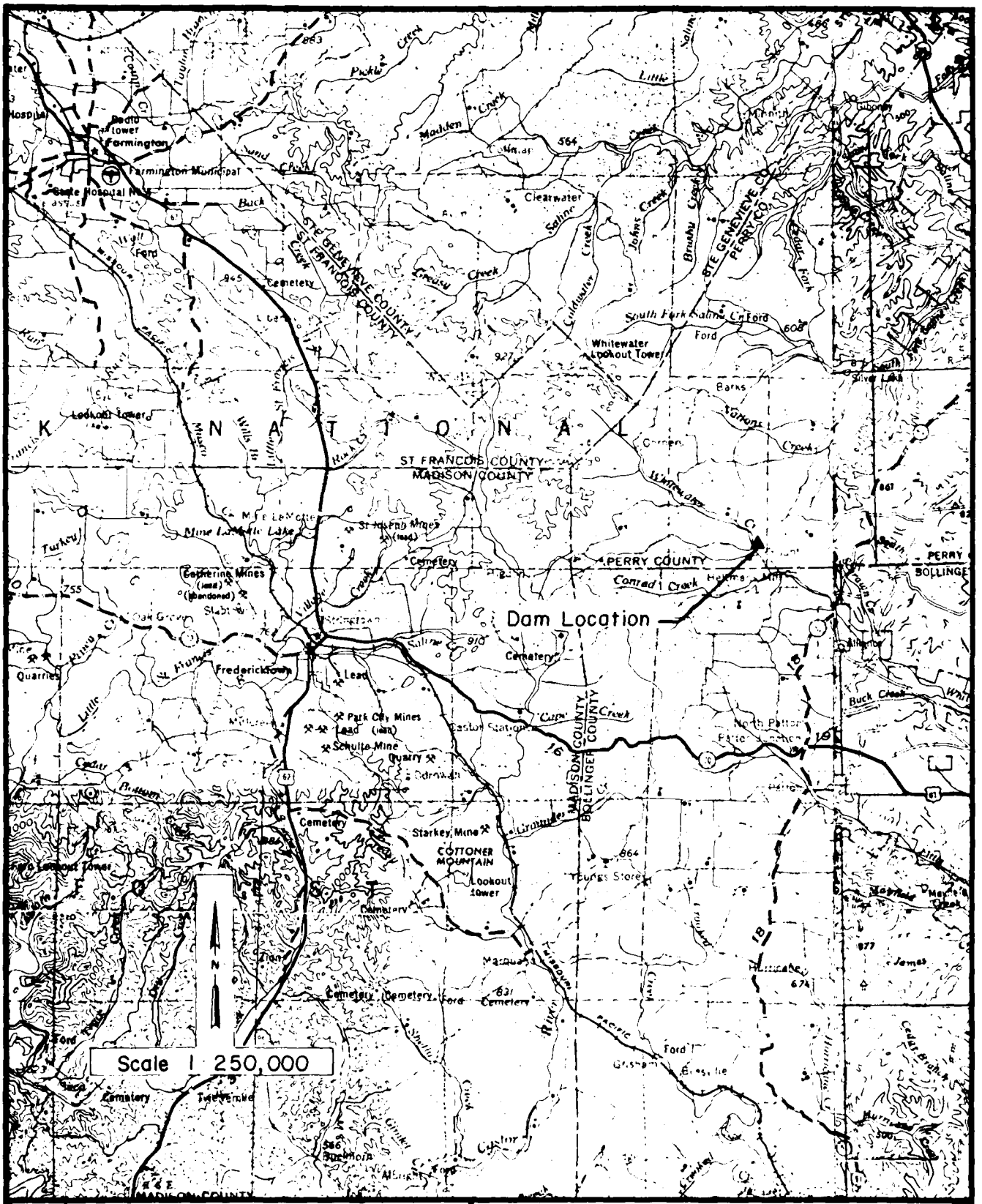
Whitewood Lake Dam
Perry County, Missouri
Mo. I.D. No. 30135

SHEET 1, APPENDIX A



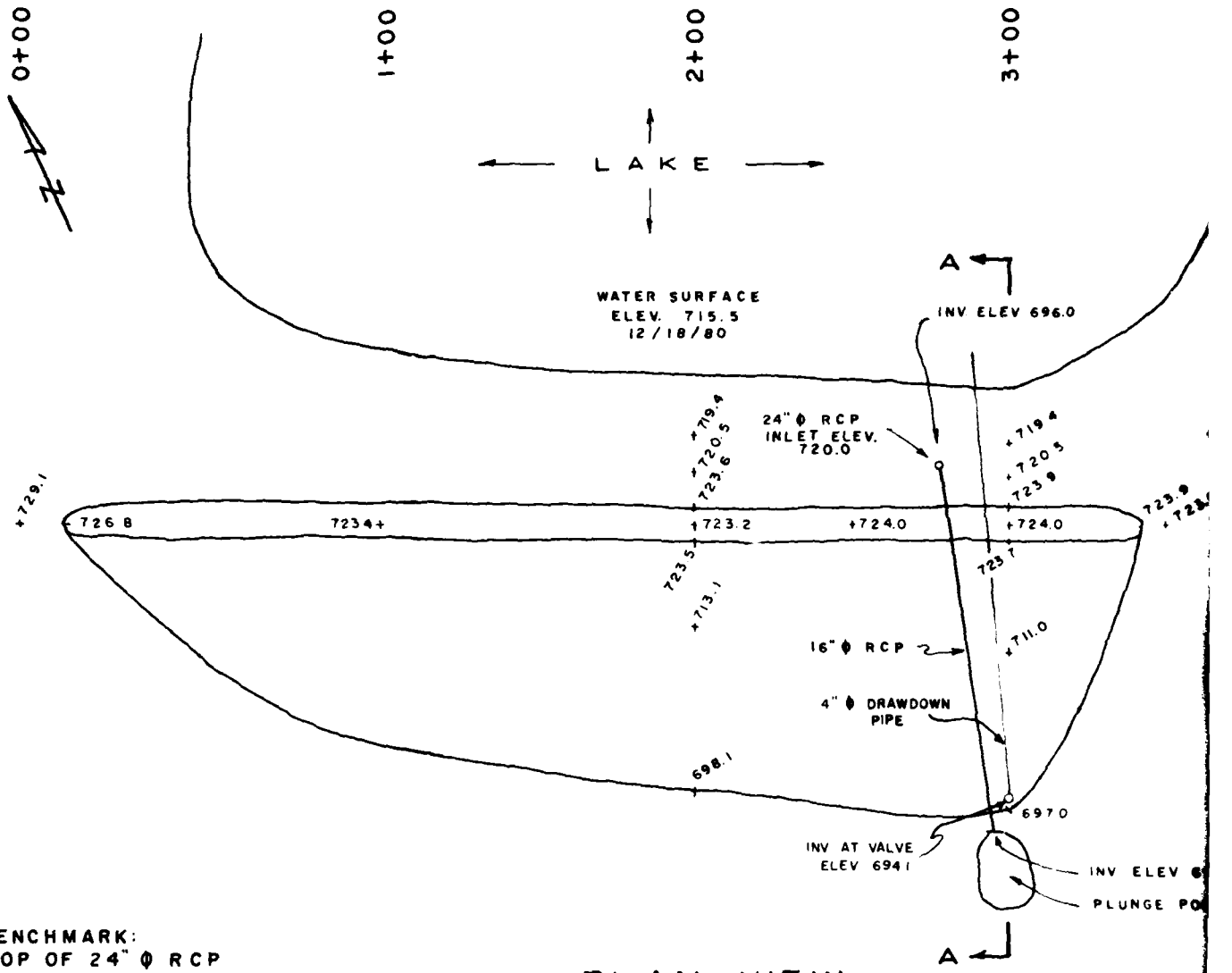
VICINITY MAP

HANSON ENGINEERS INCORPORATED

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

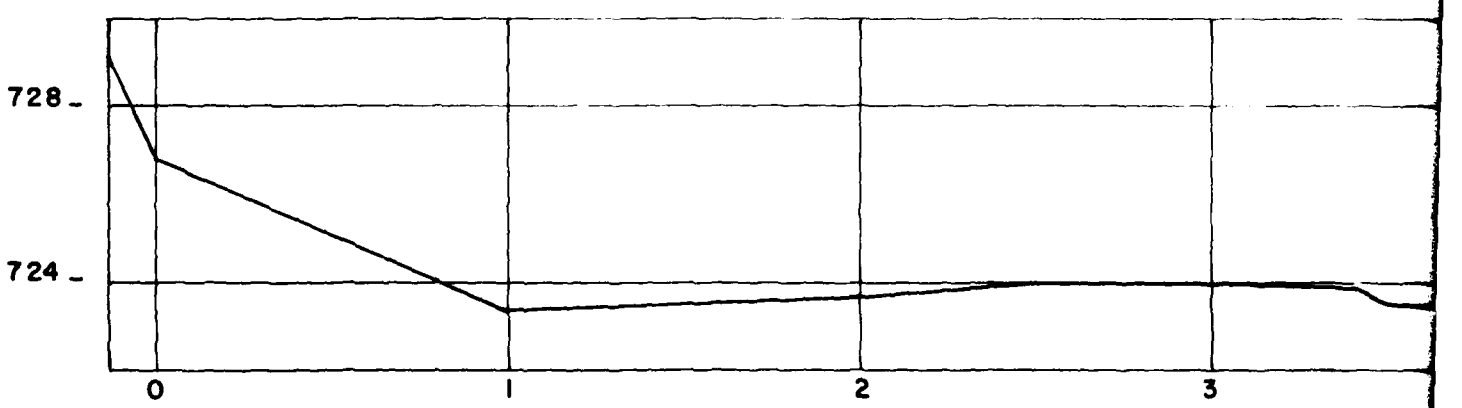
Whitewood Lake Dam
Perry County, Missouri
Mo I D No 30135

Sheet 2, Appendix A

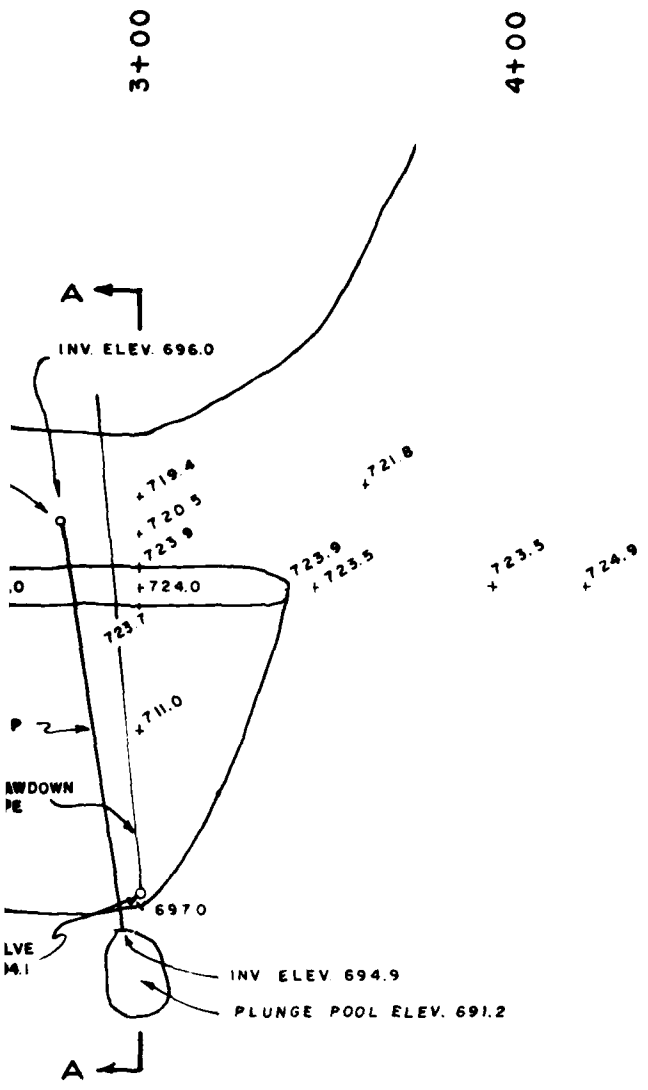


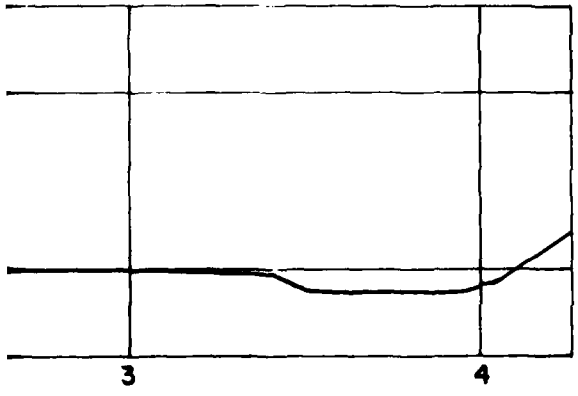
BENCHMARK:
TOP OF 24" ϕ RCP
STA 2+70, 22 FT.
LEFT ℄ DAM.
ELEV. 720.00 MSL

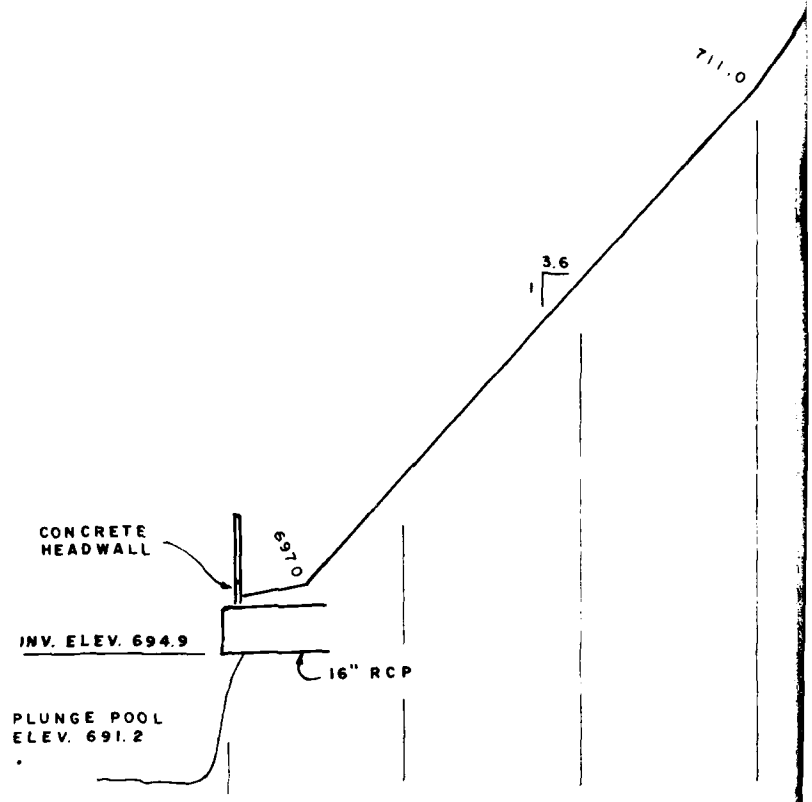
PLAN VIEW
SCALE: 1" = 50'



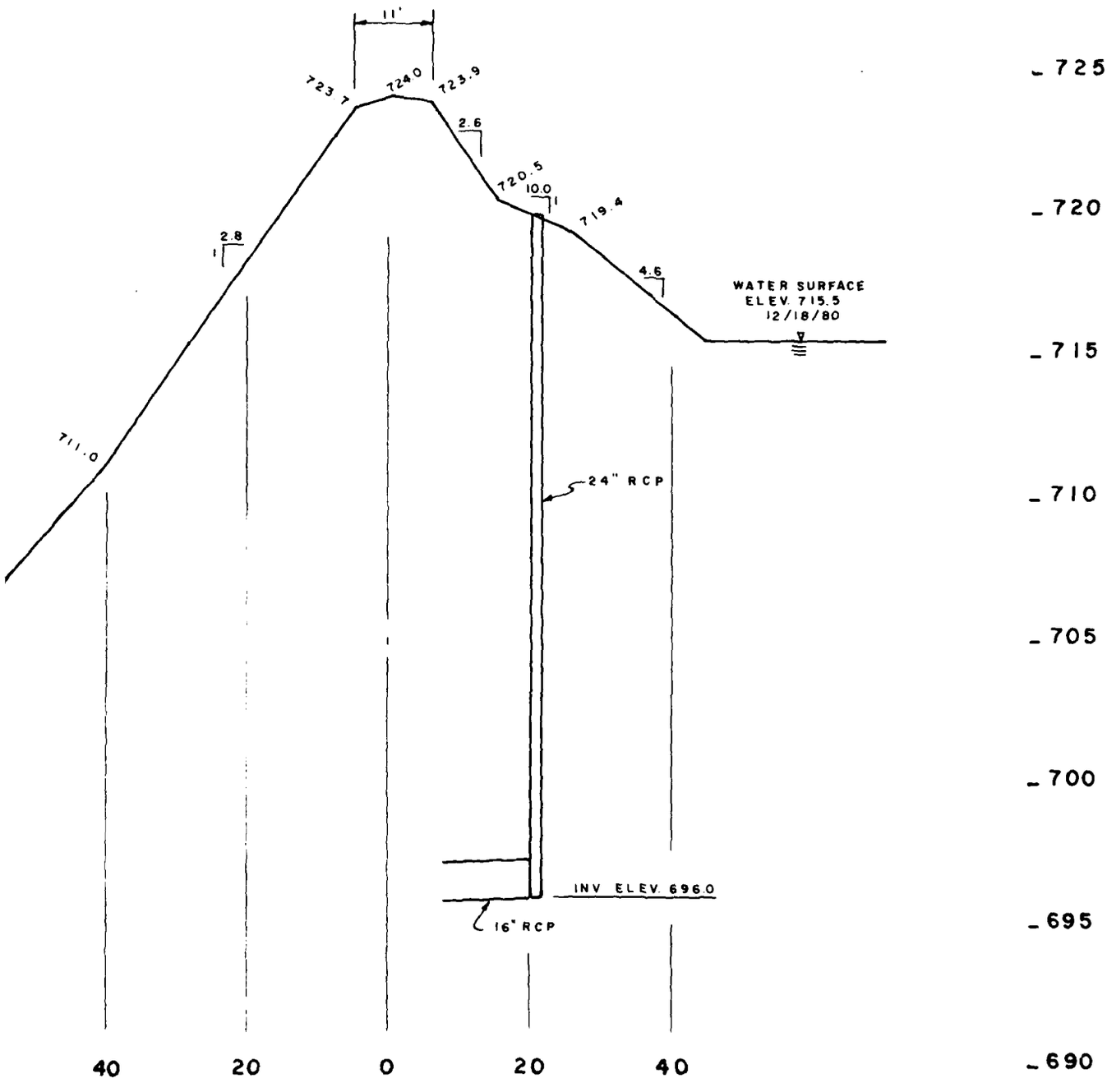
PROFILE


3+00
4+00
A
INV. ELEV. 696.0
+719.4
+720.5
+723.9
+724.0
723.7
+721.8
723.9
+723.5
+723.5
+724.9
+711.0
P 2
AWDOWN
PE
6970
LVE
M.1
INV ELEV 694.9
PLUNGE POOL ELEV. 691.2
A


728
724
3
4


711.0
3.6
1
CONCRETE
HEADWALL
697.0
INV. ELEV. 694.9
16" RCP
PLUNGE POOL
ELEV. 691.2
100
80
60
40

SECTI



SECTION A-A STA 3+00

A/E ANDERSON ENGINEERING, INC.

730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

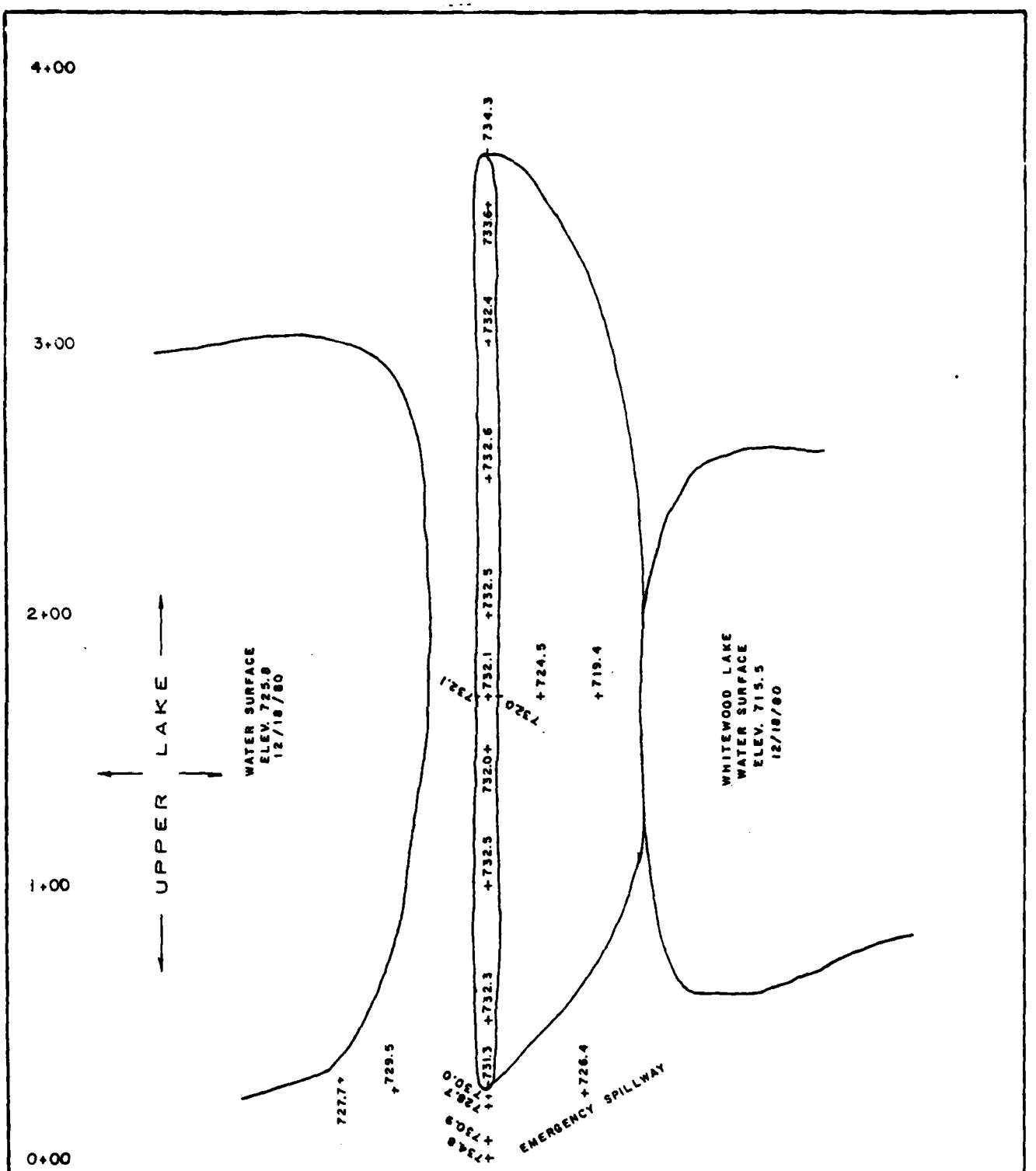
WHITEWOOD LAKE DAM

MO. No. 30135

PLAN, PROFILE, & SECTION OF DAM

PERRY COUNTY, MO.

SHEET 3, APPENDIX A



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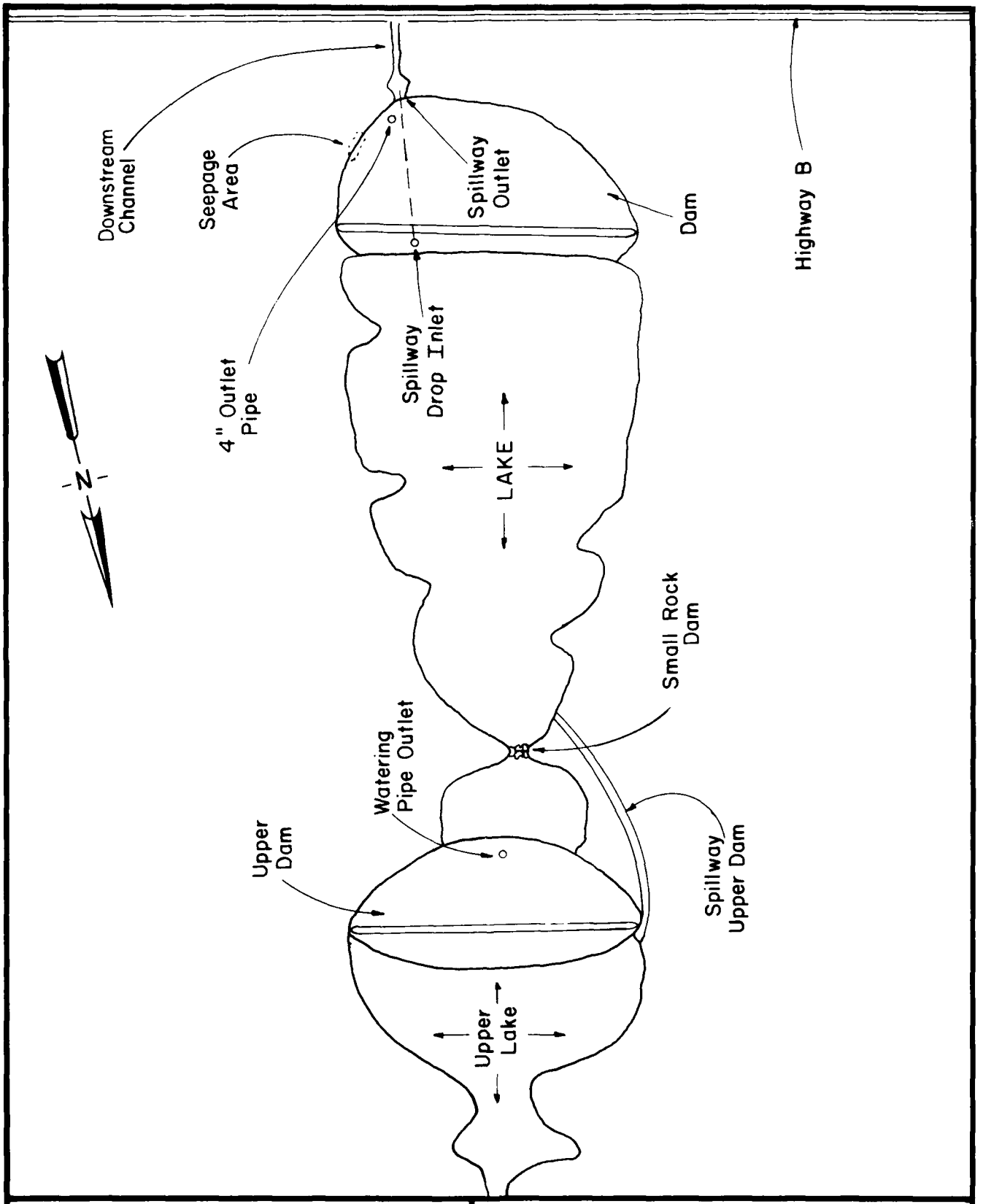
WHITEWOOD LAKE DAM
PERRY COUNTY, MISSOURI
MO. I. D. No. 30135

UPPER DAM - PLAN VIEW



PLAN SKETCH OF FEATURES

HANSON ENGINEERS INCORPORATED

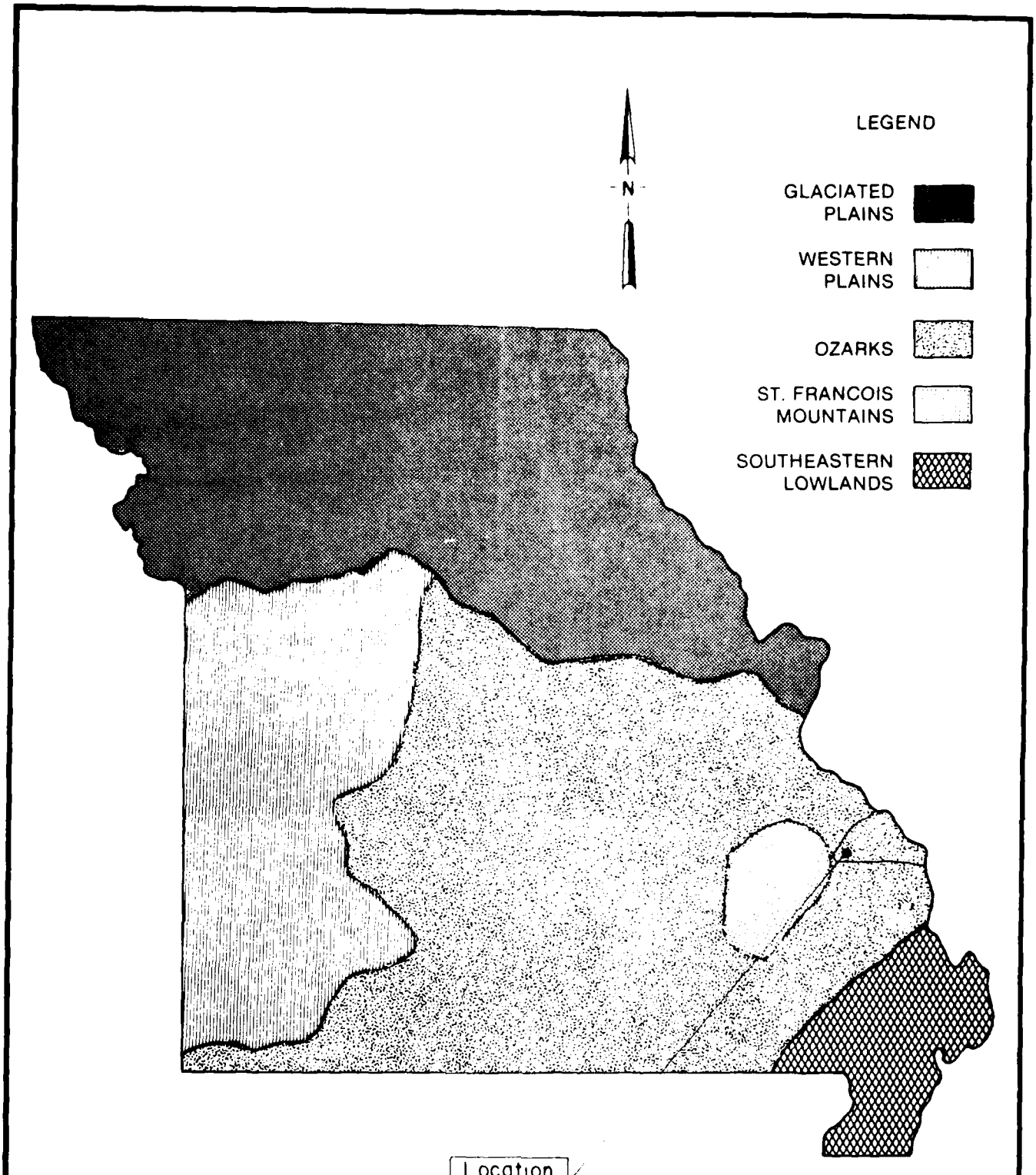
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Whitewood Lake Dam
Perry County, Missouri
Mo. I.D. No. 30135

Sheet 5, Appendix A

APPENDIX B

Geology and Soils



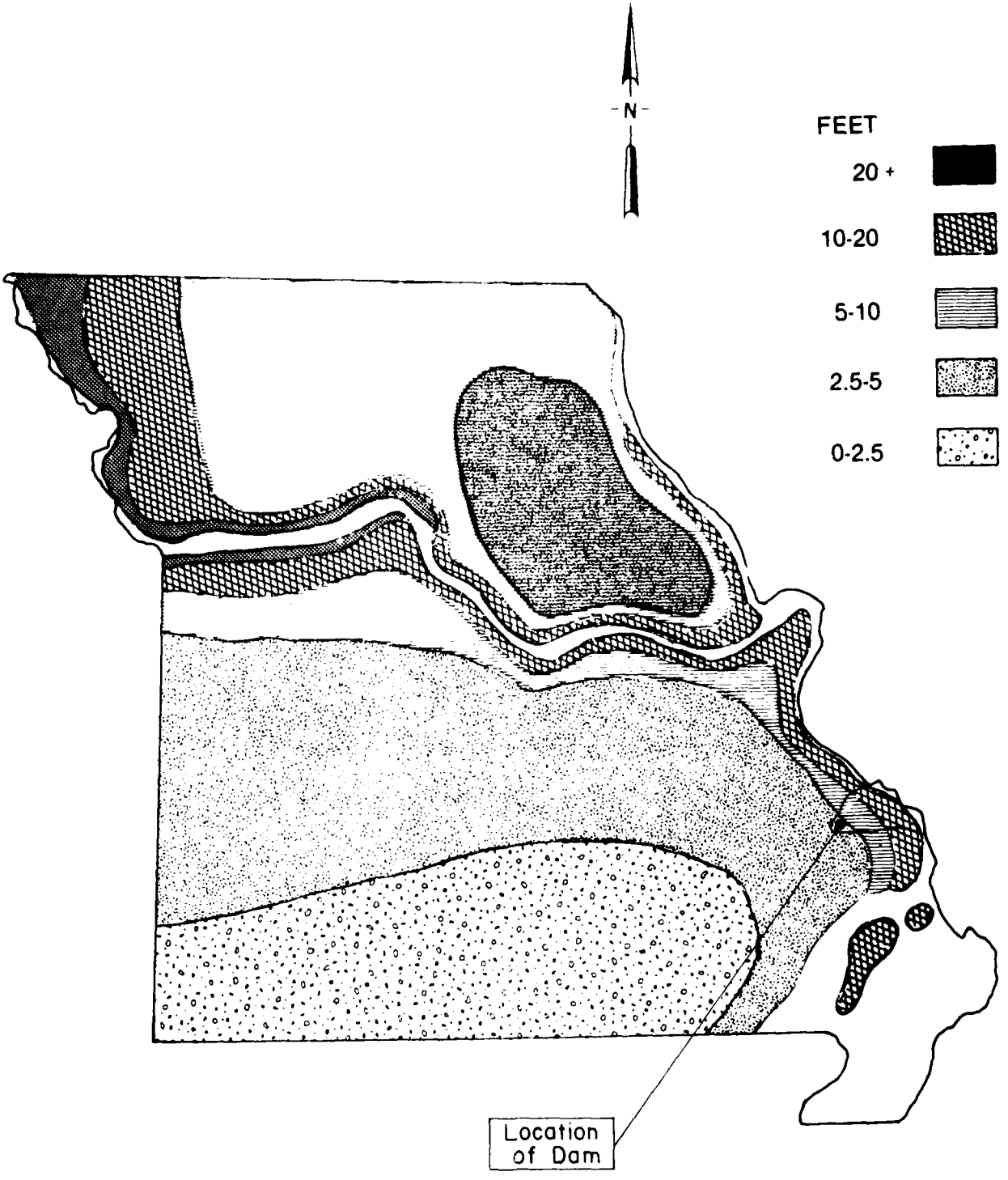
MAJOR GEOLOGIC REGIONS OF MISSOURI

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Whitewood Lake Dam
Perry County, Missouri
Mo. I.D. No 30135

SHEET 1, APPENDIX B



THICKNESS OF LOESSIAL DEPOSITS

HANSON ENGINEERS

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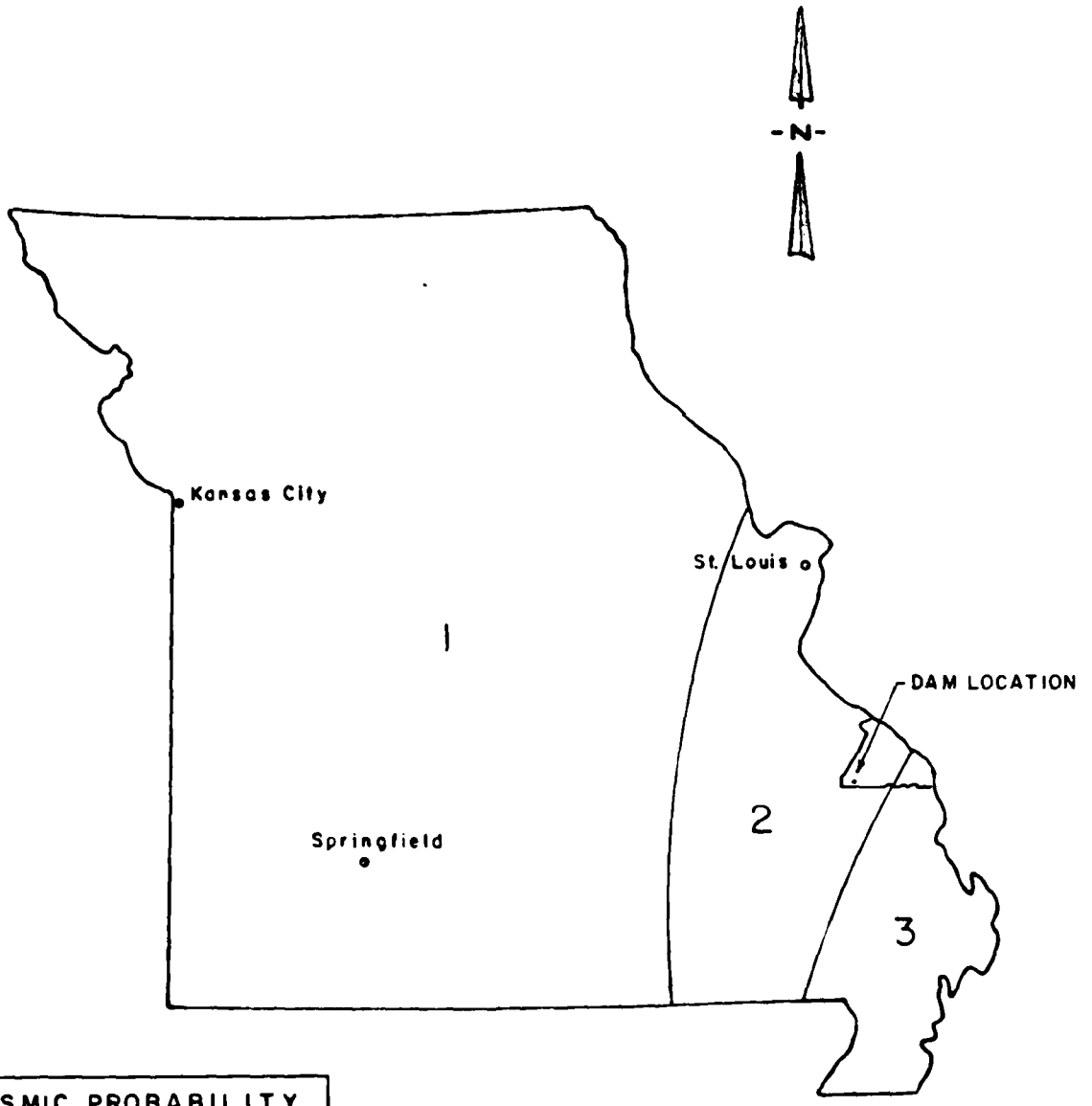
Whitewood Lake Dam
Perry County, Missouri
Mo I.D. No. 30135

SHEET 2, APPENDIX B



SEISMIC PROBABILITY	
ZONE	DAMAGE
1	MINOR
2	MODERATE
3	MAJOR

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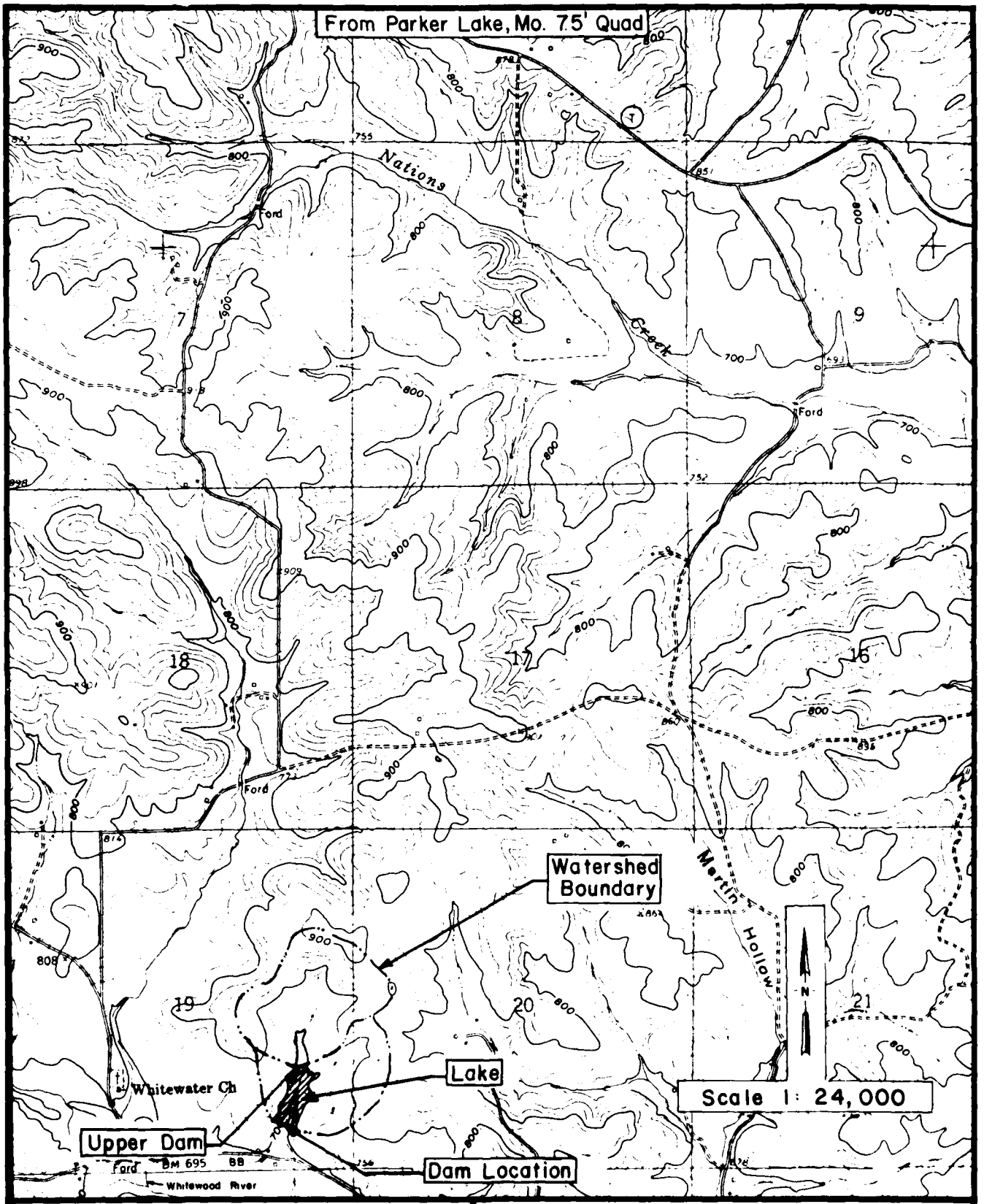
SEISMIC ZONE MAP

WHITEWOOD LAKE DAM
PERRY COUNTY, MISSOURI
MO. I. D. No. 30135

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP

HANSON ENGINEERS INCORPORATED

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Whitewood Lake Dam
Perry County, Missouri
Mo. I.D. No. 30135

Sheet 1, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. St. Genevieve, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The time of concentration was estimated using the Kirpich formula. This formula and the parameters for the unit hydrograph are shown in Table 1 (Sheet 4, Appendix C). The time of concentration was also verified from velocity estimates for the average slopes of the watershed and the main channel (Design of Small Dams, page 70, 1974 Edition).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used for the antecedent moisture conditions (AMC), and the result from the computer output, are shown in Table 2 (Sheet 5, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method assuming the starting lake elevation at normal pool. No antecedent storm was routed in order to determine the starting elevation. It was assumed that the mean annual high water elevation corresponds with the normal pool elevation. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area—storage-discharge relationships shown in Table 3 (Sheet 5, Appendix C). To consider the effect in the routing analysis of the upper dam (see Section 5 of this report), the routed outflow hydrograph from the upper dam was combined with the inflow hydrograph of the lower dam. Then, the combined hydrograph was routed through the reservoir and spillway of the lower dam. The effect of the upper dam was studied, assuming separately, that the upper dam will resist overtopping and that the upper dam will breach during overtopping.

The rating curve for the spillway (see Table 4 Sheet 6, Appendix C) was determined assuming a concrete pipe with entrance and outlet control.

The flow over the crest of the dam during overtopping was determined using the non-level dam option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The lowest elevation of the crest of the dam, obtained from survey measurements, was assumed as top of dam elevation.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 7, Appendix C). The result of the routings indicates that the spillway will pass the 1 percent probability flood without overtopping the dam.

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF, assuming that the upper dam will not breach due to overtopping, are presented on Sheets 8 to 11 of Appendix C. The input and output data for the routing of the PMF, assuming the breach of the upper dam, are shown on Sheets 12, 13, and 14 of Appendix C.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.08	sq miles(*)
Length of Watercourse (L)	0.28	miles
Difference in elevation (H)	160	ft
Time of concentration (Tc)	0.10	hrs
Lag Time (Lg)	0.06	hrs
Time to peak (Tp)	0.10	hrs
Peak Discharge (Qp)	390	cfs
Duration (D)	5	min.

Time (Min.)(**)	Discharge (cfs)(**)
0	0
5	355
10	196
15	51
20	13
25	4
30	0

(*) Drainage area downstream of the upper dam (total drainage area equals 0.20 sq miles)

(**)From the computer output

FORMULA USED:

$$Tc = \left(\frac{11.9\ L^3}{H}\right)^{0.385}$$

Kirpich Formula.
From California Culverts Practice, California Highways and Public Works, September, 1942.

$$Lg = 0.6\ Tc$$

$$Tp = \frac{D}{2} + Lg$$

$$Qp = \frac{484\ A.Q}{Tp}$$

Q = Excess Runoff = 1 inch

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	34.3	33.0	1.3
1% Prob. Flood	24	34.3	32.4	1.9

Additional Data:

1) Soil Conservation Service Soil Group C
2) Soil Conservation Service Runoff Curve CN = 88 (AMC III) for the PMF
3) Soil Conservation Service Runoff Curve CN = 75 (AMC II) for the 1 percent probability flood
4) Percentage of Drainage Basin Impervious 15 percent

TABLE 3

ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
692.0	0	0	-
700.0	1.4	6	-
*720.0	7.5	95	0
**723.4	8.6	122	41
725.0	9.1	136	43
730.0	10.8	186	-
740.0	14.0	-	-

*Principal spillway crest elevation
**Top of dam elevation

The above relationships were developed using data from the USGS Parker Lake, Missouri 7.5 minute quadrangle map with a 20 ft contour interval, and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (MSL)	Principal Spillway (cfs)
720.0	0
721.0	20
722.0	40
723.0	41
*723.4	41
724.0	42
725.0	43
726.0	44
727.0	45

* Top of dam elevation

Method Used: Using charts for concrete pipes with entrance and outlet control from the U. S. Bureau of Public Roads.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft) Over Top of Dam
-	0	*720.0	95	0	-
0.05	98	721.1	104	22	-
0.10	197	722.2	113	40	-
0.15	377	723.6	124	60	0.2
0.20	570	723.9	126	172	0.5
0.25	726	724.3	130	482	0.9
0.30	900	724.5	131	728	1.1
0.50	1,575	724.9	135	1,400	1.5
0.75	2,410	725.3	139	2,172	1.9
1.00	3,250	725.7	142	2,970	2.3

The percentage of the PMF that will reach the top of the dam is about 15 percent.

*Principal spillway crest elevation
Top of dam elevation = 723.4

```
A        OVERTOPPING ANALYSIS FOR WHITE WOOD LAKE DAM ( # 7 )
A        STATE ID NO. 30135  COUNTY NAME : PERRY
A        HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 81S3001
B    288                 5
B1     5
J      1        9        1
J1   .05      .10      .15      .20      .25      .30      .50      .75      1.0
K      0        1                                  3        1
K1       INFLOW HYDROGRAPH COMPUTATION FOR THE UPPER LAKE
M      1        2    0.12                0.12        1                          1
P      0     26.4      102      120      130
T                                                                -1      -85              0.04
W2  0.10     0.06
X      0       -.1        2
K      1        2                            0        4        1
K1       RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE (UPPER DAM)
Y                                    1        1
Y1     1                                                        20       -1
Y4 731.0    732.0    733.0    734.0    735.0    736.0    737.0    738.0
Y5     0       60      150      295      460      690      950     1270
$S     0       20       23       32       54
$E 715.0    731.0    732.0    735.0    740.0
$$ 731.0
$D 732.0
$L     0       50      175      225      275      325      345      355      365
$V 732.0    732.3    732.5    732.6    732.9    733.6    734.3    735.0    736.0
K      0        3                                  4        1
K1       INFLOW HYDROGRAPH COMPUTATION FOR WHITE WOOD LAKE
M      1        2    0.08                0.08        1                          1
P      0     26.4      102      120      130
T                                                                -1      -88              0.15
W2  0.10     0.06
X      0       -.1        2
K      2        4                                  4        1
K1       COMBINE OUTFLOW HYDROGRAPH FROM UPPER LAKE AND INFLOW HYD.FOR WHITE WOOD LAKI
K      1        5                            0        4        1
K1       RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE ( WHITE WOOD LAKE)
Y                                    1        1
Y1     1                                                        95       -1
Y4 720.0    721.0    722.0    723.0    724.0    725.0    726.0    727.0
Y5     0       20       40       41       42       43       44       45
$S     0       95      122      136      186
$E 692.0    720.0    723.4    725.0    730.0
$$ 720.0
$D 723.4
$L     0       85      180      250      325      375      425      475
$V 723.4    723.5    723.7    724.0    724.0    725.0    726.0    727.0
K     99
```

PMF RATIOS
(ASSUMING NO BREACH OF THE UPPER DAM)

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.05	RATIO 2 0.10	RATIO 3 0.15	RATIO 4 0.20	RATIO 5 0.25	RATIO 6 0.30	RATIO 7 0.50	RATIO 8 0.75	RATIO 9 1.00
HYDROGRAPH AT	1	0.12	1	105.	209.	314.	419.	523.	628.	1046.	1569.	2093.
	(	0.31)	(	2.96)(	5.93)(	8.89)(	11.85)(	14.81)(	17.78)(	29.63)(	44.44)(	59.26)
ROUTED TO	2	0.12	1	40.	96.	218.	359.	461.	558.	929.	1384.	1850.
	(	0.31)	(	1.14)(	2.71)(	6.19)(	10.15)(	13.07)(	15.81)(	26.30)(	39.18)(	52.38)
HYDROGRAPH AT	3	0.08	1	70.	140.	210.	280.	350.	420.	700.	1049.	1399.
	(	0.21)	(	1.98)(	3.96)(	5.94)(	7.92)(	9.90)(	11.89)(	19.81)(	29.71)(	39.62)
2 COMBINED	4	0.20	1	98.	197.	377.	570.	726.	901.	1575.	2410.	3249.
	(	0.52)	(	2.78)(	5.57)(	10.68)(	16.15)(	20.56)(	25.52)(	44.61)(	68.24)(	91.99)
ROUTED TO	5	0.20	1	22.	40.	60.	172.	482.	728.	1405.	2172.	2974.
	(	0.52)	(	0.62)(	1.14)(	1.69)(	4.87)(	13.64)(	20.62)(	39.78)(	61.52)(	84.22)

SUMMARY OF DAM SAFETY ANALYSIS

PMF RATIOS
OUTPUT DATA (1-2)
ASSUMING NO BREACH OF THE
UPPER DAM

SUMMARY OF DAM SAFETY ANALYSIS

UPPER DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	731.00	731.00	732.00
STORAGE	20.	20.	23.
OUTFLOW	0.	0.	60.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.05	731.67	0.00	22.	40.	0.00	15.83	0.00
0.10	732.30	0.30	24.	96.	0.50	15.75	0.00
0.15	732.64	0.64	25.	218.	0.92	15.67	0.00
0.20	732.83	0.83	25.	359.	1.83	15.67	0.00
0.25	732.94	0.94	26.	461.	3.58	15.67	0.00
0.30	733.04	1.04	26.	558.	5.00	15.67	0.00
0.50	733.33	1.33	27.	929.	6.58	15.67	0.00
0.75	733.63	1.63	28.	1384.	7.33	15.67	0.00
1.00	733.89	1.89	29.	1850.	7.83	15.58	0.00

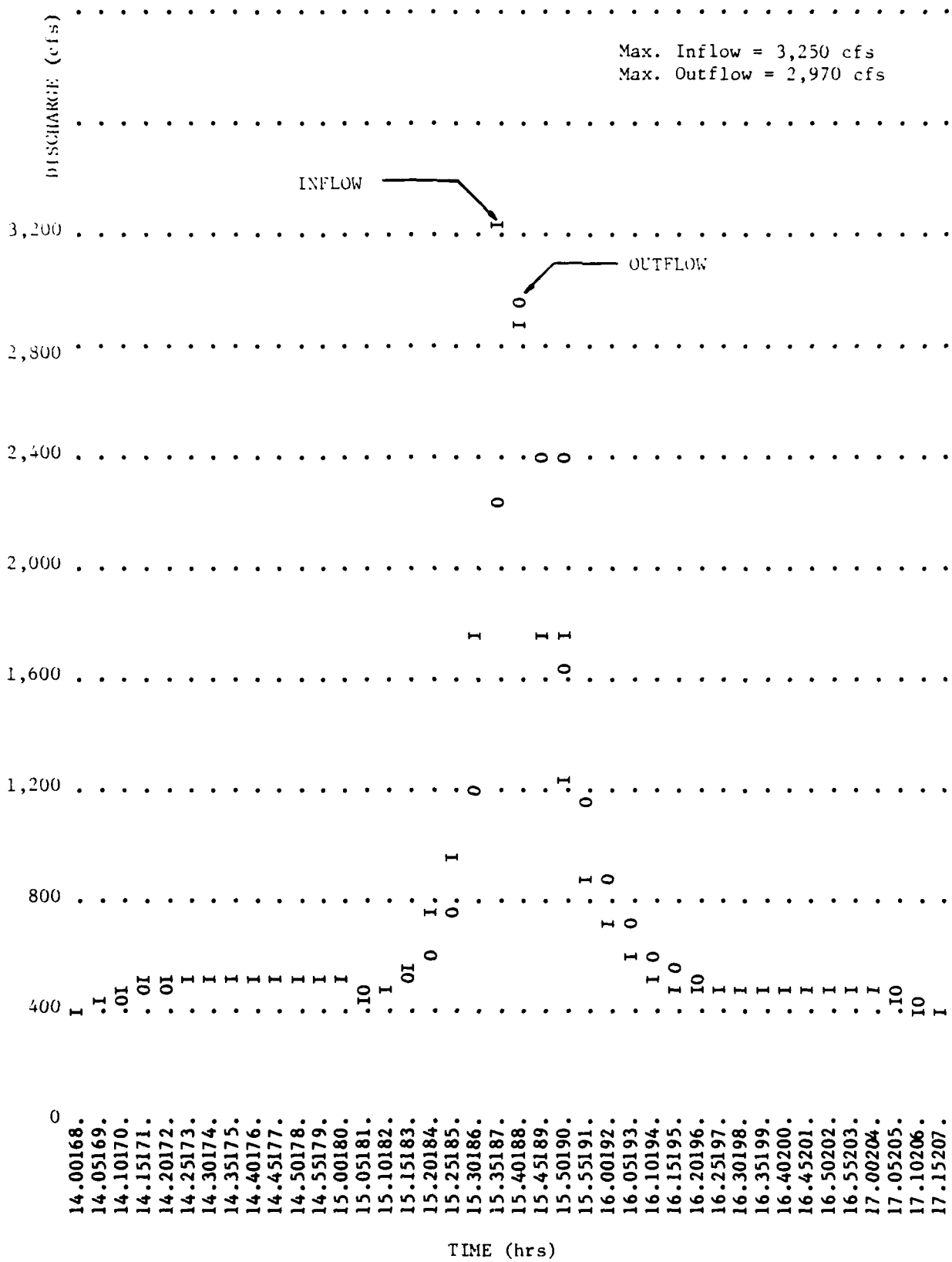
SUMMARY OF DAM SAFETY ANALYSIS

WHITEWOOD LAKE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	720.00	720.00	723.40
STORAGE	95.	95.	122.
OUTFLOW	0.	0.	41.

PMF RATIOS
OUTPUT DATA (2-2)
ASSUMING NO BREACH OF UPPER DAM

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.05	721.09	0.00	104.	22.	0.00	17.58	0.00
0.10	722.23	0.00	113.	40.	0.00	18.00	0.00
0.15	723.60	0.20	124.	60.	3.00	18.00	0.00
0.20	723.90	0.50	126.	172.	4.50	16.00	0.00
0.25	724.26	0.86	130.	482.	4.92	15.75	0.00
0.30	724.46	1.06	131.	728.	5.67	15.67	0.00
0.50	724.90	1.50	135.	1405.	7.83	15.67	0.00
0.75	725.29	1.89	139.	2172.	9.42	15.67	0.00
1.00	725.65	2.25	142.	2974.	11.50	15.67	0.00



INFLOW-OUTFLOW HYDROGRAPH
FOR THE PMF

Sheet 11, Appendix C

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A       OVERTOPPING ANALYSIS FOR WHITE WOOD LAKE DAM ( # 7 )(BREACH ANALYSIS)
A       STATE ID NO. 30135  COUNTY NAME : PERRY
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 81S3001
B    288                5
B1     5
J      2        1        1
J1   1.0
K      0        1                                  3        1
K1      INFLOW HYDROGRAPH COMPUTATION FOR THE UPPER LAKE
M      1        2    0.12              0.12        1                          1
P      0     26.4     102      120      130
T                                                              -1      -85              0.04
W2  0.10     0.06
X      0     -.1        2
K      1        2                           0        4        1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE (UPPER DAM)
Y                                  1        1
Y1     1                                                      20       -1
Y4 731.0    732.0    733.0    734.0    735.0    736.0    737.0    738.0
Y5     0       60      150      295      460      690      950     1270
$S     0       20       23       32       54
$E 715.0    731.0    732.0    735.0    740.0
$$ 731.0
$D 732.0
$L     0       50      175      225      275      325      345      355      365
$V 732.0    732.3    732.5    732.6    732.9    733.6    734.3    735.0    736.0
$B    10      0.5    720.0      0.5    731.0   733.88
$B    10      0.5    720.0      0.5    731.0    732.0
K      0        3                                  4        1
K1      INFLOW HYDROGRAPH COMPUTATION FOR WHITE WOOD LAKE
M      1        2    0.08              0.08        1                          1
P      0     26.4     102      120      130
T                                                              -1      -88              0.15
W2  0.10     0.06
X      0     -.1        2
K      2        4                                  4        1
K1      COMBINE OUTFLOW HYDROGRAPH FROM UPPER LAKE AND INFLOW HYD.FOR WHITE WOOD LAKE
K      1        5                           0        4        1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE ( WHITE WOOD LAKE)
Y                                  1        1
Y1     1                                                      95       -1
Y4 720.0    721.0    722.0    723.0    724.0    725.0    726.0    727.0
Y5     0       20       40       41       42       43       44       45
$S     0       95      122      136      186
$E 692.0    720.0    723.4    725.0    730.0
$$ 720.0
$D 723.4
$L     0       85      180      250      325      375      425      475
$V 723.4    723.5    723.7    724.0    724.0    725.0    726.0    727.0
K     99
```

PMF INPUT DATA
ASSUMING BREACH OF THE UPPER DAM

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	RATIOS APPLIED TO FLOWS PLAN	RATIO 1 1.00
HYDROGRAPH AT	1	0.12	1	2093.
	(	0.31)	(	59.26)(
			2	2093.
			(	59.26)(
ROUTED TO	2	0.12	1	1850.
	(	0.31)	(	52.38)(
			2	1711.
			(	48.46)(
HYDROGRAPH AT	3	0.08	1	1399.
	(	0.21)	(	39.62)(
			2	1399.
			(	39.62)(
2 COMBINED	4	0.20	1	3249.
	(	0.52)	(	92.00)(
			2	2798.
			(	79.23)(
ROUTED TO	5	0.20	1	2669.
	(	0.52)	(	75.56)(
			2	2661.
			(	75.36)(

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

UPPER DAM

Failure El. 733.88

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	731.00	731.00	732.00
STORAGE	20.	20.	23.
OUTFLOW	0.	0.	60.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	735.88	3.88	36.	1850.	3.95	15.58	15.58

Failure El. 732.0

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	731.00	731.00	732.00
STORAGE	20.	20.	23.
OUTFLOW	0.	0.	60.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	732.14	0.14	23.	1711.	0.24	15.67	12.08

SUMMARY OF DAM SAFETY ANALYSIS

WHITE WOOD LAKE DAM

Failure El. 733.88

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	720.00	720.00	723.40
STORAGE	95.	95.	122.
OUTFLOW	0.	0.	41.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	725.52	2.12	141.	2669.	11.00	15.67	0.00

Failure El. 732.0

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	720.00	720.00	723.40
STORAGE	95.	95.	122.
OUTFLOW	0.	0.	41.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	725.51	2.11	141.	2661.	11.00	15.67	0.00

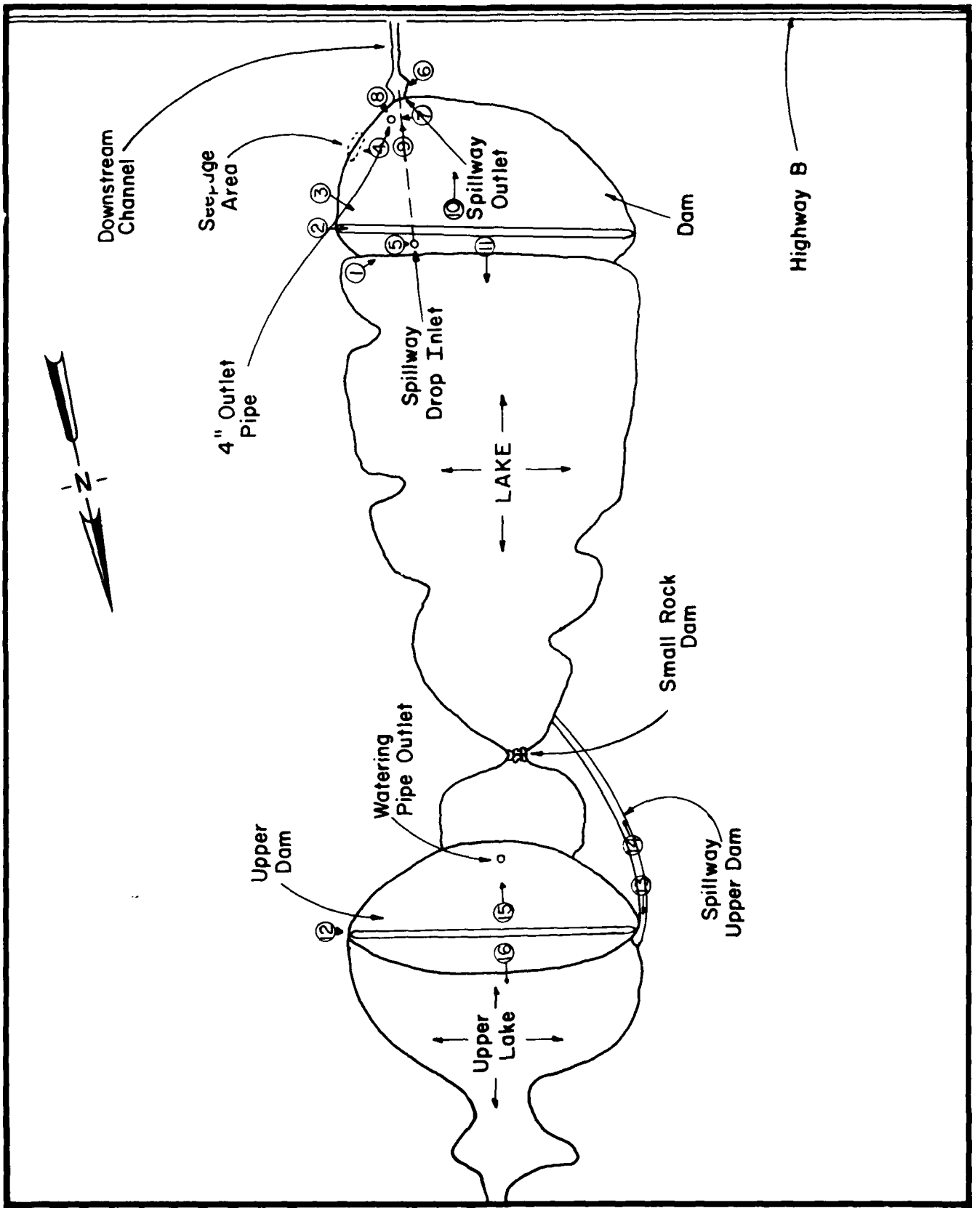
PMF OUTPUT DATA (2-2)
ASSUMING BREACH OF UPPER DAM

APPENDIX D

Photographs

INDEX TO PHOTOGRAPHS

Photo No.	Description
1.	Upstream face of dam, looking west from left abutment. Note spillway drop inlet in middle of photograph.
2.	Crest of dam, looking west from left abutment.
3.	Downstream face of dam looking northwest from left abutment.
4.	Seepage area, left abutment contact.
5.	Spillway drop inlet.
6.	Spillway outlet, note small trickle of water flowing with lake level below drop inlet crest.
7.	Drawdown pipe outlet.
8.	Drawdown pipe outlet, note small pipe with two valves stemming from larger drawdown pipe.
9.	Downstream channel, looking south.
10.	Downstream area from crest of dam, Highway B in center of photograph.
11.	View of lake from crest of dam, note upper dam in center of photograph.
12.	Crest of upper dam, looking east from right abutment.
13.	Spillway of upper dam, looking downstream.
14.	Spillway of upper dam, looking downstream.
15.	Whitewood Lake looking south from upper dam, note Whitewood Lake Dam in center of photograph.
16.	Upper lake from crest of upper dam.
17.	Aerial view of lake and dam, looking northwest, note upper lake and dam in upper right of photograph.
18.	Aerial view of downstream face, looking north.
19.	Aerial view of dam looking east.
20.	Aerial view of "upper dam" looking east.



PHOTOGRAPH LOCATIONS

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

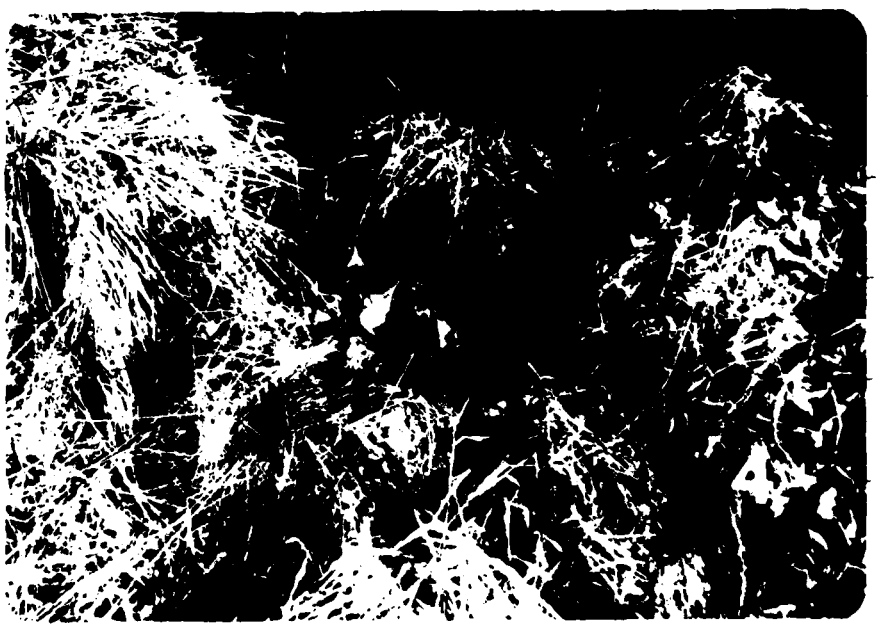
Whitewood Lake Dam
Perry County, Missouri
Mo. I.D. No. 30135

Sheet 2, Appendix D


1


2


3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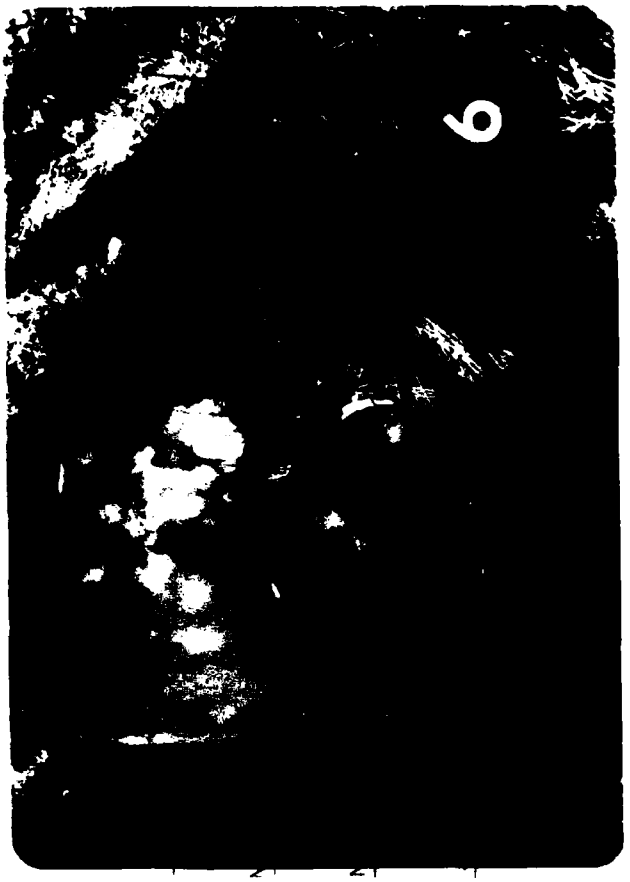
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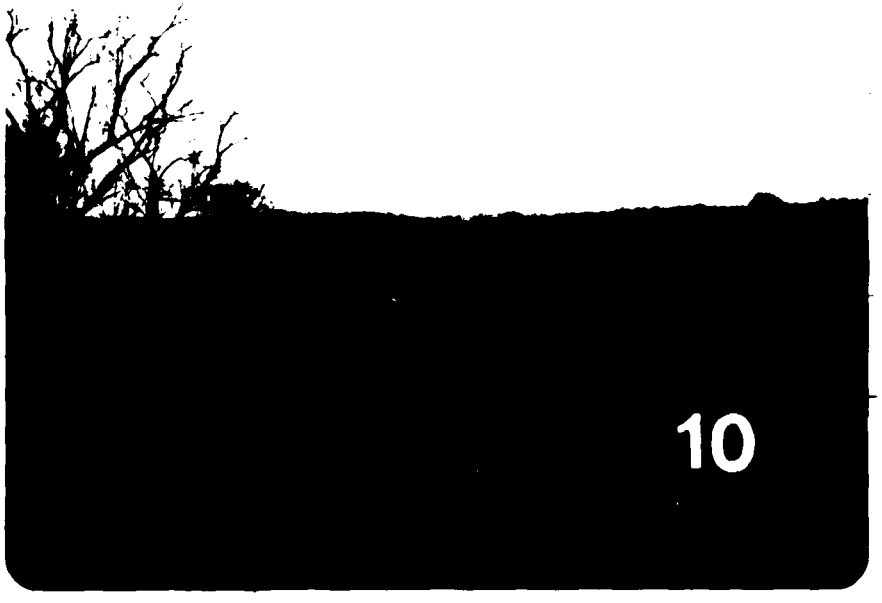
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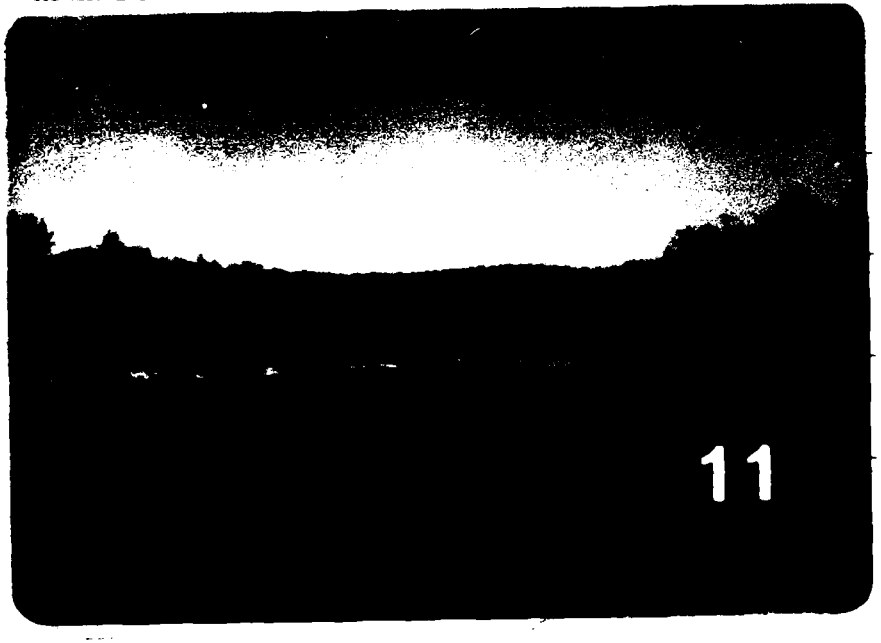
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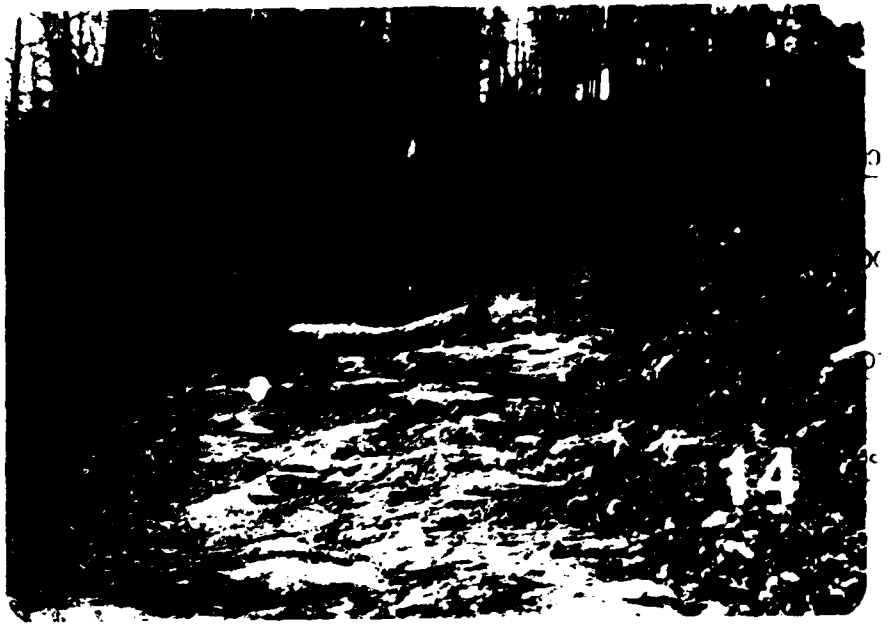
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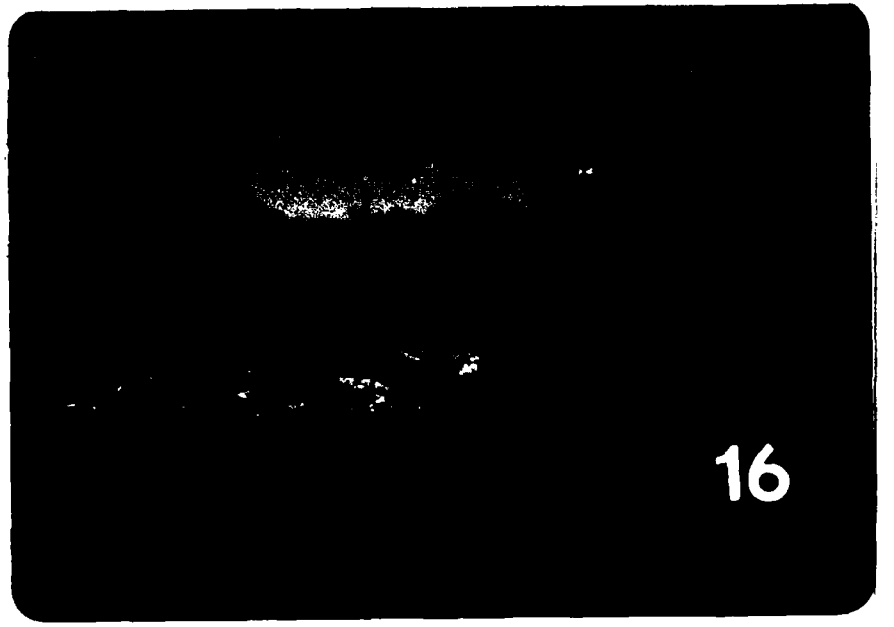
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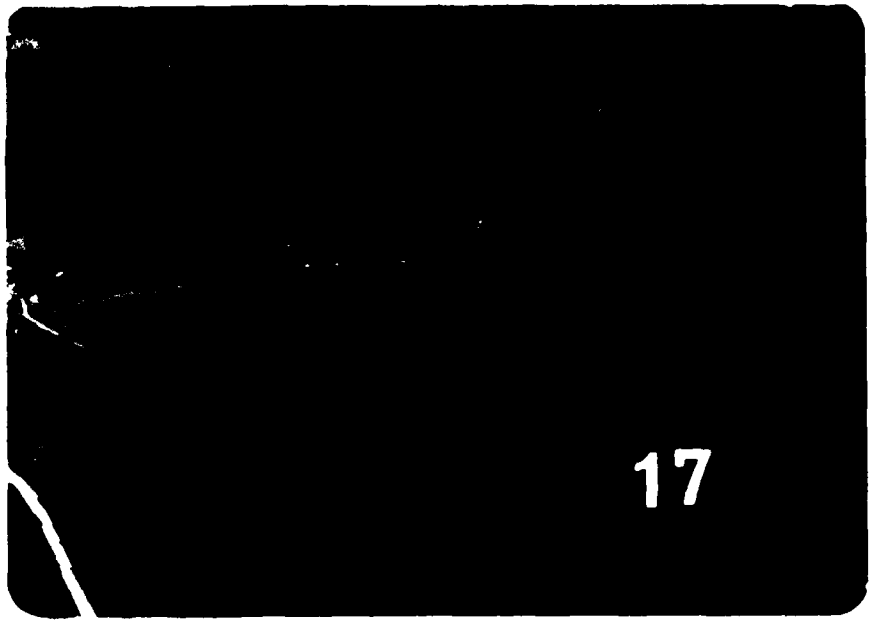
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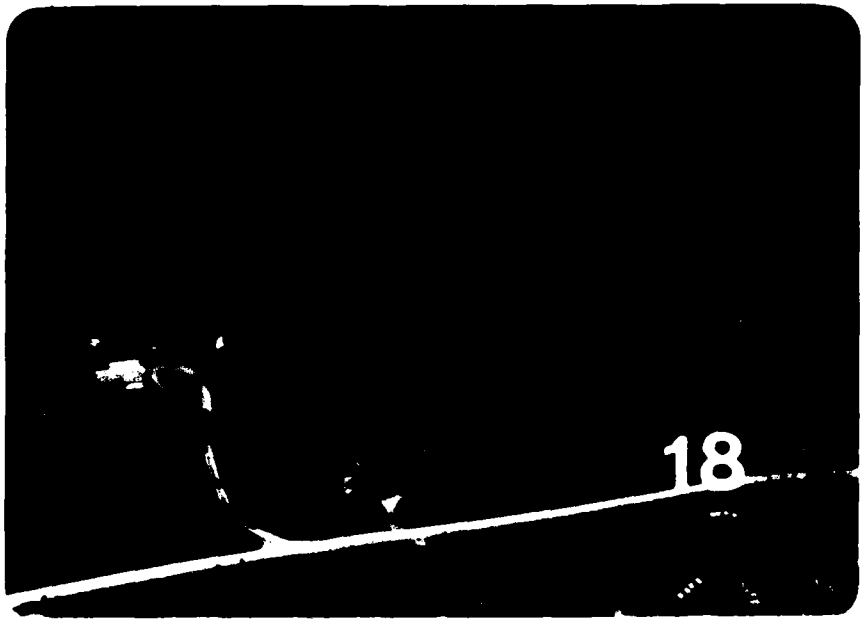
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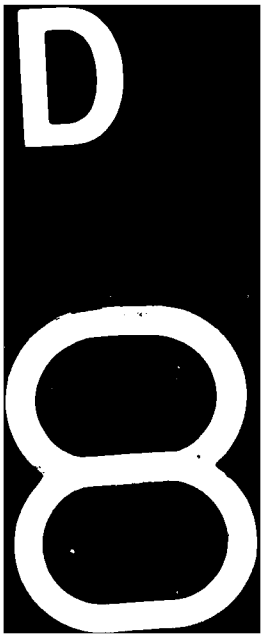
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